Childhood Maltreatment, Gender Nonconformity, and Adolescent Sexual Orientation: A Prospective Birth Cohort Study

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Abstract

This study tested whether associations between childhood maltreatment and adolescent sexual orientation were accounted for by childhood gender nonconformity (GNCB) in a prospective birth cohort (N = 5007). Childhood parental maltreatment (physical and emotional) and GNCB were assessed on multiple occasions up to age 6-years, and sexual orientation at 15.5 years. Boys with a history of maltreatment were significantly more likely to be non-heterosexual. Using propensity score weighting, maltreatment was associated with a 3.5% (p=.03) increase in the prevalence of non-heterosexuality accounting for confounders not including GNCB, and by 2.9% (p=.06) when also accounting for GNCB. These findings suggest that maltreatment is associated with an increased prevalence of non-heterosexuality in boys but may be explained by confounding factors including GNCB.

Keywords: gender nonconformity, sexual orientation, childhood maltreatment, homosexuality, ALSPAC.

Introduction

Non-heterosexual men and women are at higher risk of childhood maltreatment including physical abuse, emotional abuse, sexual abuse, and neglect than their heterosexual counterparts in cross-sectional and epidemiological studies. Compared to heterosexuals, the odds of maltreatment among non-heterosexuals in individual studies range from 1.2 to a 12.8 (Corliss, Cochran, & Mays, 2002; Roberts, Austin, Corliss, Vandermorris, & Koenen, 2010; Saewyc, Skay, Pettingell, & Reis, 2006; Sweet, & Welles, 2012). A meta-analysis showed smaller odds ratios (1.3 to 2.9 times greater risk) but an association nonetheless (Friedman et al., 2011). Several hypotheses have been proposed to explain this association. These include maltreatment triggered by revealing one's same-sex sexuality in adolescence, or greater exposure of non-heterosexuals to early maltreatment through placing themselves in risky contexts (Saewyc et al., 2006); biased retrospective recall of maltreatment by non-heterosexuals (Corliss et al., 2002); and that greater childhood gender nonconformity among non-heterosexuals makes them targets for maltreatment (Roberts, Rosario, Corliss, Koenen, & Austin, 2012a).

Another set of hypotheses is that childhood maltreatment may directly cause or shape non-heterosexual orientation. Hypothesised mechanisms include conditioned same-sex attractions in response to same-gender sexual abuse among boys and, among girls, aversion towards sexual relations with men in response to sexual abuse perpetrated by men; that maltreatment among same-sex attracted persons may lead to the adoption of formal non-heterosexual identity labels later in life; or some other form of generalized learned responses whereby childhood maltreatment cascades into later minority sexual orientation (LeVay, 1996). One epidemiological study using an instrumental variable method reported that history of sexual abuse predicted increased prevalence of non-heterosexuality: increased by 0.7% for same-sex identity and 2.0% for same-sex attraction (Roberts, Glymour, &

Koenen, 2013). This relationship was stronger in men than women, contrary to the suggestion that psychosocial influences are more likely to influence female than male sexual orientation (Bailey et al., 2016). The effects of non-sexual maltreatment were significant only for men and women's same-sex identity and same-sex behavior.

Prior work on the association between childhood maltreatment and sexual orientation has several limitations. Studies have used cross-sectional designs, and measured childhood maltreatment retrospectively (even where data were originally collected prospectively; Roberts, Rosario, Corliss, Koenen, & Austin, 2012b). These carry the risk of recall biases and do not provide tests of causal pathways. Third variables, such as shared genetic factors, could affect both the non-heterosexuality and instrumental variables that Roberts et al. (2013) used (Bailey & Bailey, 2013; Bailey, Ellingson, & Bailey, 2014).Thus, longitudinal designs (where maltreatment precedes sexual orientation) combined with methods to enhance causal interpretations, such as propensity score analysis (Lee & Little, 2017), should be applied to test the relationship between maltreatment and sexual orientation in order to get closer to a causal explanation. Longitudinal designs could also test for selection effects due to theoretically important variables also measured before sexual orientation, namely childhood gender nonconforming behavior (GNCB).

The hypothesis that GNCB could make pre-homosexual (or non-heterosexual) children vulnerable to maltreatment has empirical support. Non-heterosexual men and women are, on average, gender nonconforming in their sex-typed behavior compared to heterosexuals during childhood (Bailey & Zucker, 1995). GNCB among non-heterosexuals is robustly evidenced in prospective and retrospective studies (Bailey & Zucker, 1995; Li, Kung, & Hines, 2017). Cross-sectional and population studies show that non-heterosexual men who were more gender nonconforming in childhood were significantly more likely to report increased childhood maltreatment than their gender-conforming counterparts (Roberts et al., 2012a; Xu

& Zheng, 2017). Non-heterosexuals who display GNCB are more likely to be targets for bullying by peers at school (Toomey, Ryan, Diaz, Card, & Russell, 2010), report greater verbal and physical victimization over the lifetime (e.g., victimization beginning at about 13 years, D'Augelli, Grossman, & Starks, 2006), and sexual abuse (Roberts et al., 2012a; Roberts et al., 2012b). As pre-homosexual children are likely to be gender nonconforming, this may negatively influence relationships with parents. Parents may try to discourage GNCB via maltreatment because it does not conform to gender role expectations, or because it forecasts a non-heterosexual orientation (Bos, de Haas, & Kuyper, 2019; Kane, 2006). GNCB has found to be associated with both parental and maternal rejection in childhood among homosexual men (Landolt, Bartholomew, Saffrey, Oram, & Perlman, 2004), and emotional neglect, psychological and physical abuse by an adult family member before 16 (Bos et al., 2019; Roberts, Rosario, Slopen, Calzo, & Austin, 2013). One study reported that GNCB partly explained the higher risk of physical abuse by an adult family member before 11 among some sexual minority groups (Roberts, et al., 2012b). Another study showed that the association between ratings of parent-child relationship traits and sexual orientation weakened or became non-significant once GNCB was controlled (Bell, Weinberg, & Hammersmith, 1981). Again, such studies provide only week indications of causation and have recall biases by way of measuring maltreatment and GNCB retrospectively.

The role of childhood experiences (e.g., maltreatment) in sexual orientation is controversial. The history of research in this area has tended to see psychosocial explanations as more stigmatizing of minority sexual orientation than biological ones (LeVay, 1996). However, robust investigations of psychosocial influences can enhance our basic scientific understanding of the biopsychosocial influences on the lifecourse development of sexual orientation and mental health. While sexual orientation has a modest genetic component, the observation that most monozygotic (MZ) twins of a non-heterosexual co-twin are

heterosexual point to environmental influences (Bailey et al., 2016; Watts, Holmes, Raines, Orbell, & Rieger, 2018). Further understanding of pathways between maltreatment and sexual orientation is important to inform the development of interventions to help reduce the burden of maltreatment upon sexual orientation-related health disparities (Saewyc et al., 2006).

Here we test the influence of GNCB on the association between early childhood parental maltreatment and later adolescent sexual orientation in a British prospective birth cohort, using causal reference techniques, propensity score analysis. Propensity score analysis is a method for creating equivalent groups via accounting for imbalance in covariates between exposed and comparison groups. Propensity score analysis attempts to replicate the properties of a randomized controlled experiment via equating participants on observed covariates when random assignment is not ethical or practical. This allows researchers to address selection biases and get closer to causal associations (Garrido et al., 2014). Here we test a pathway from childhood parental maltreatment to sexual orientation. We use logistic regression to test whether there is an association between childhood parental maltreatment and sexual orientation and whether this association is confounded by GNCB. To get closer to causal associations, we also use propensity score analysis to test whether childhood maltreatment is associated with sexual orientation and whether this causal association could be explained by the additional inclusion of GNCB (perhaps because GNCB results in greater maltreatment) in the propensity score construction. Even though both approaches may lead to similar conclusions in terms of associations, we are more likely to be able to infer causation from the propensity score analysis. We hypothesized that this association (for logistic regression) or "causal" association (for propensity score analysis) would be reduced after controlling for GNCB. This hypothesis is tested separately for boys and girls given that psychosocial factors are hypothesized to exert greater influence over sexual orientation in females than males

(Bailey et al., 2016). Our analyses control for theoretically important biodemographic and psychosocial covariates.

Method

Participants

Participants were part of the Avon Longitudinal Study of Parents and Children (ALSPAC). All pregnant women with an expected date of delivery between 1st April 1991 and 31th December 1992 in the Bristol area of the South West of UK were eligible and invited to attend the ALSPAC. The initial number of pregnancies recruited was 14,541, resulting in 14,062 live-born children and 13,988 children who were alive at 1 year. Additional recruitment attempting to bolster the original sample with eligible cases who had failed to join the study at the beginning resulted in 15458 fetuses with data collected from the age of seven onwards. Of this total sample of 15,458 fetuses, 14,775 were live births and 14,701 were alive at 1 year of age. Fifty-nine percent of the cohort attended the "Teen Focus" and have been followed four times between they were 12.5 years old and 17 years old. For more details, see Boyd et al. (2013) and Fraser et al. (2013). The study website contains details of all the data, which are available through a fully searchable data dictionary: http://www.bris.ac.uk/alspac/ researchers/data-access/data-dictionary/. Ethical approval for the study was obtained from the ALSPAC Law and Local Research Ethics Committees, and a research ethics subcommittee of a local university.

The current study analyzed ALSPAC data reported by both the parents and children across different time points. Children who reported a valid response of sexual orientation and sexual behavior (details about sexual behavior measurement are in Supplemental Text 1) at 15.5 years old were included in this study, $N = 5{,}007$ (2,349 male and 2,658 female). With our sample size, we have 80% power to detect an odds ratio of at least 2.57 at the 5% significance level for both propensity score analysis and logistic regression based on power

simulation (Demidenko, 2007; Feiveson, 2002). Converted to the Cohen's *d* metric, an odds ratio of 2.57 equates to a Cohen's *d* of .52, which is generally considered to be a medium effect (Borenstein, Hedges, Higgins, & Rothstein, 2009). It is important to note that power is based on the total sample size and the cases to controls, not the size of either group (heterosexuals or non-heterosexuals) individually.

Measures

Sexual Orientation

At age of 15.5 years, adolescents were required to answer the question: "Please choose the description that best fits how you think about yourself" on a 5-point Kinsey-like scale: 1 = *100% heterosexual*, 2 = *mostly heterosexual but also attracted to the same sex*, 3 = *bisexual (equally attracted to both sexes)*, 4 = *mostly homosexual but also attracted to the opposite sex*, 5 = *100% homosexual*, 6 = *not sexually attracted to either sex*, and 7 = *not sure*. This was done via computer to promote disclosure of sensitive personal information. It appears to be appropriate to begin measuring sexual orientation via sexual attractions at 15.5 years old. One study reported a mean age of self-reported first awareness of same-sex attraction at approximately 15 years (Calzo, Antonucci, Mays, & Cochran, 2011). Some studies report even earlier recalled mean age of awareness of same-sex attractions (Floyd & Bakeman, 2006). Changes in reported sexual orientations were also found to occur at a similar rate throughout adolescence and into emerging adulthood (Ott, Corliss, Wypij, Rosario, & Austin, 2011).

Adolescents who chose "*not sexually attracted to either sex*" (n = 17) or "*not sure*" (n = 91) were excluded from analyses (2.11%). This is because we had no priori predictions about the role of maltreatment and gender nonconformity in adolescents with ambiguous or no reported sexual attractions and most such adolescents as heterosexual later in life (Ott et al., 2011). Such 5-point scales of sexual attractions show good psychometric properties and low

nonresponse rates in adolescents and young adults (Ott et al., 2011). Adolescents who chose *100% heterosexual* or *mostly heterosexual but also attracted to the same sex* were coded as heterosexual, those who chose *bisexual* were coded as bisexual, and those who chose *mostly homosexual but also attracted to the opposite sex* or *100% homosexual* were coded as homosexual. As a result, 2,290 heterosexual boys, 29 bisexual boys, 30 homosexual boys, 2,585 heterosexual girls, 56 bisexual girls, and 17 homosexual girls were included. The sample sizes of bisexuals and homosexuals were relatively small, even though much higher proportion of heterosexuals is consistent with population rates of non-heterosexuality (Bailey et al., 2016). Given these small sub-groups, and that bisexual boys and girls did not differ from their homosexual counterparts in the odds of being maltreated and GNCB (See Supplemental Text 2), we grouped bisexuals and homosexuals into one non-heterosexual group for boys and girls separately. As a result, 2,290 heterosexual boys, 59 non-heterosexual boys, 2,585 heterosexual girls, 73 non-heterosexual girls were included.

Childhood Parental Maltreatment

When the adolescents in the analysis sample were 8 months, 1 year 9 months, 2 years 9 months, 3 years 11 months, 5 years 1 month, and 6 years 1 month old, adolescents' mothers were required to report whether their children have experienced childhood parental maltreatment on a four-item scale (See Supplemental Figure 1 for the prevalence of childhood maltreatment stratified by sex, age, and maltreatment type). These items were "your husband/partner was physically cruel to your children", "you were physically cruel to your children", "your husband/partner was emotionally cruel to your children", and "you were emotionally cruel to your children". Items were measured on a 5-point scale: 1 = *yes and affected respondent a lot*, 2 = *yes and moderately affected respondent*, 3 = *yes and mildly affected respondent*, 4 = *yes but did not affect respondent at all*, and 5 = *no and did not happen*. The first assessment was based on the experiences since the adolescents were born,

and all subsequent assessments were based on the interval between successive assessment time points. Childhood parental maltreatment was coded as present if mothers reported that their children had experienced emotional or physical abuse at any time point (e.g., choose 1, 2, 3, or 4 for any items, which provides a confirmation of maltreatment taking place and a judgement about its effect on the child). The measure of childhood maltreatment focused on physical and emotional maltreatment, not sexual. The measure was also caregiver-reported rather than child-reported.

The items used here were from a life events inventory based on those developed by Barnett, Hanna, and Parker (1983), Brown and Harris (1978), and Honnor, Zubrick, and Stanley (1994), and have been widely used in prior studies (e.g., Lereya, Copeland, Costello, & Wolke, 2015; Sidebotham, 2000). For example, children from the ALSPAC who had been placed on the Child Protection Register for maltreatment were more likely to have parental reports of both physical and emotional cruelty (Sidebotham, 2000) and those reporting emotional or physical cruelty received less maternal care than the population as a whole (Collishaw, Dunn, O'connor, Golding, & ALSPAC Study Team, 2007) offering evidence of validity of this measure of childhood maltreatment. To further test the validity, we assessed associations with other theoretically relevant constructs reported by mothers (prenatal and postnatal maternal anxiety or depression, and parental absence) and the adolescents (relationship with parents) (Sidebotham, Golding, & ALSPAC Study Team, 2001). Adolescents with parental absence, greater prenatal and postnatal maternal anxiety or depression, and poorer relationship with parents were significantly more likely to be maltreated by their parents in childhood (See Supplemental Table 3). The small-to-moderate associations there support the construct validity of the child maltreatment measure.

GNCB

When the adolescents in the analysis sample were 2 year 6 months, 3 years 6 months, and 4

years 9 months old, mothers of the adolescents were required to rate their children's gender behaviors using the Preschool Activities Inventory (PSAI) (Golombok & Rust, 1993). PSAI is a validated self-report questionnaire (Golombok & Rust, 1993). The PSAI consists of 12 male-typical items and 12 female-typical items assessing children's toy preferences, activities, and interests. Responses to each item were scored on a 5-point Likert scale ranging from 1 = *never* to 5 = *very often*. The PSAI is scored via deducting the total score for female-typical items from the total score for the male-typical items, then transforming to a pseudo-*T* scale by multiplication with 1.10 and adding 48.25 (Golombok & Rust, 1993). Consequently, a higher score indicates more male-typical behavior and less female-typical behavior for girls and boys. An average of the three PSAI scores was derived and used in the analysis.

Biodemographic and Psychosocial Covariates

Several covariates were measured. These included birthweight, pubertal body mass index, gestational age, parental age, prenatal maternal anxiety or depression, postnatal maternal anxiety or depression, number of older brothers, number of older sisters, duration of breastfeeding, parental absence, number of house moves, child's reported relationship with parents, family socioeconomic position, digit ratio (a marker ascribed to the prenatal actions of androgens), and handedness(see Supplemental Text 1 for full details).

Statistical Analysis

Missing Data

The variables had 2.78% - 56.80% missing information (see Table 1 for key variables and Supplemental Table 1 and 2 for covariates). Sexual orientation had no missing information. Our other key variables (GNCB and childhood maltreatment) have relatively low missing information and missing information is mainly due to covariates. To tackle power and sample size issues, the missing data were handled using multiple imputation in Stata 15.1 stratified

by sex. For the imputation model, prior studies have suggested that all variables in the analysis model and auxiliary variables should be included in the imputation model (White, Royston, & Wood, 2011). Thus, sexual orientation, GNCB, childhood parental maltreatment, potential covariates, and an auxiliary variable (sexual behavior) were included in the imputation model. Recommendations suggest that the number of imputations should be at least as large as the percentage of missing data (White et al., 2011). In our case, we used 57 imputations. We used the chained equations algorithm (MICE) model since we have a combination of continuous and categorical variables. The continuous variables were not normally distributed (*Shapiro-Francia* test showed that all *p*s < .001). Consequently, we used predictive mean matching with 10 nearest-neighbor donors since this approach makes no distributional assumptions, can maintain the underlying distributions of the data, gives acceptable estimates, and performs robustly even if distributional assumptions are violated (Kleinke, 2017, Vink, Frank, Pannekoek, & Van Buuren, 2014). After imputation, logistic regressions and propensity score analyses were conducted in each imputed dataset separately and then the estimates from 57 imputed datasets were combined using methods suggested by Rubin (2009).

Imputation for mother absence failed to converge due to small cell sizes. A Meta-analysis also found that the association between parental absence and reproductive outcomes did not differ significantly across type of parental absence (Xu, Norton, & Rahman, 2018). Thus, we were forced to combine father absence and mother absence into one variable labelled "parental absence" (never with father or mother, either parent absence before 7 years, either parent absence since 7 years, and both parents presence) (Supplemental Table 1 and 2). Trace plots and other diagnostics provided no obvious cause for concern regarding the imputed values. Sensitivity analysis comparing analyses based on complete-case and imputed data were not performed due to the proportion of missing data in the sample.

Propensity Scores Analysis

We tested the pathway from childhood parental maltreatment to sexual orientation (heterosexual vs. non-heterosexual). Accordingly, we conducted logistic regression and propensity score analysis with childhood parental maltreatment as predictor and sexual orientation as outcome.

For logistic regression without propensity score weighting, we created two models: Model 1 controlled for all covariates except GNCB and Model 2 further controlled for GNCB. We then conducted propensity score weighting to test the relationship between childhood parental maltreatment and sexual orientation using two models: Model 3 used all covariates except GNCB in the propensity score construction and Model 4 additionally included GNCB in the propensity score construction. To do this, we conducted logistic regression with childhood parental maltreatment as outcome and covariates as independent variables to create propensity score for each imputed dataset. Recommendations suggest that variables that are related to both treatment and outcome or are only related to the outcome but not to the treatment should be included as covariates (Garrido et al., 2014; Lee & Little, 2017). Accordingly, univariate logistic regressions were conducted with sexual orientation as outcome and potential covariates as independent variables to decide which variables to be included in the propensity score (significant covariates based on the pooled results across 57 imputed datasets were included in the propensity score analysis. See Supplemental Table 3). The balance of propensity scores across exposed and comparison groups were checked graphically (see Supplemental Figure 2 to 5). The mean propensity score across 57 imputed data was used. The propensity score displayed a similar distribution in the exposed (adolescents with history of childhood parental maltreatment) and comparison (adolescents with no history of childhood parental maltreatment) groups. We then used the inverse-probability weighting (*teffects ipw* command in Stata 15.1) to estimate the average

treatment effects. Finally, balance of covariates after weighting was checked via computing the standardized difference between comparison (adolescents with no history of childhood maltreatment) and exposed (adolescents with history of childhood maltreatment) groups (Supplemental Table 4 and 5). The mean standardized difference across 57 imputed datasets was used. The standardized differences between adolescents with and with no history of childhood parental maltreatment in all covariates were less than 0.25, which indicate adequate balance in all covariates (Lee & Little, 2017). Analyses were carried out separately for boys and girls in Stata 15.1.

Model Performance

Simulation studies show that our model fitting approaches (logistic regression and propensity score analysis) are appropriate and have good empirical power (e.g., Cepeda, Boston, Farrar, & Strom, 2003). In order to directly test the internal validation of our model fitting approach, we performed k-fold cross-validation (Steyerberg et al., 2001). Each imputed dataset was randomly split into ten folds of approximately equal size. Nine folds were used as training data and the excluded fold was retained as the validation data for testing our models. The process was repeated 10 times for each imputed dataset. Ten results from the folds then was averaged across 57 imputed datasets to produce a single estimation. The area under the receiver operating characteristic curve (AUC) was used as the model performance index (Steyerberg et al., 2001). The resulting AUCs for the logistic regression models for boys ranged from .69 to .75 and .63 to .69 for girls indicating good fit of those models. Note, cross-validation is not an appropriate approach for testing model fitting of propensity score analysis because they result in artificially lower predicted probabilities given that such models only include the treatment variable in the final model. So we would necessarily expect the "fit" of propensity score models to look worse compared to regression model where all covariates are incorporated in the model. The goal of a propensity model is not

necessarily to have the best fitting model but rather an estimate for a single coefficient to permit a theoretically motivated causal interpretation (as one would in an experimental design). However, the predicted probabilities from in-sample and out-of-sample estimates were almost the same which supports the validity of propensity score analysis.

Results

Sexual Orientation and Childhood Parental Maltreatment

Childhood parental maltreatment was experienced by 12.10% of heterosexual boys, 25.86% of non-heterosexual boys, 12.19% of heterosexual girls, and 13.24% of non-heterosexual girls in our sample. Non-heterosexual boys were significantly more likely to report having been maltreated by their parents in childhood than their heterosexual counterparts, odds ratio = 2.51, 95% confidence interval (CI) = [1.38, 4.58], $p = .003$. Non-heterosexual girls also reported a greater odds of being maltreated by their parents in childhood compared to heterosexual girls, though the effect was small and the difference was not significant, odds ratio = 1.09, 95%CI = [0.53, 2.23], $p = .812$

Sexual Orientation and GNCB

Boys and girls who displayed more GNCB were significantly more likely to be non-heterosexual (odds ratio = 1.11, 95%CI = [1.07, 1.15], $p < .001$ and odds ratio = 1.07, 95%CI = [1.04, 1.11], $p < .001$ for boys and girls respectively). Boys and girls who displayed more GNCB were also significantly more likely to have increased childhood parental maltreatment, odds ratio = 1.02, 95%CI = [1.01, 1.04], $p = .010$ and odds ratio = 1.02, 95%CI = [1.00, 1.03], $p = .017$ for boys and girls respectively.

Sexual Orientation, GNCB, and Childhood Parental Maltreatment

The main results of the logistic regression (Models 1 and 2) and propensity score weighted analysis (Models 3 and 4) are presented in Table 2. To aid clarity Table 2 shows the average marginal effects for Models 1 and 2, and average treatment effects for Models 3 and

4. Compared to boys with no history of childhood parental maltreatment, the prevalence of non-heterosexuality among boys who experienced childhood parental maltreatment was increased by 3.00%, 95%CI = [0.27%, 5.74%], p = .031, in Model 1. This association was reduced to non-significance in Model 2, p = .089. For the non-significant association, we performed an equivalence test using the two-one sided test procedure (Lakens, 2017). We set the equivalence bounds to be [-1.00%, 4.00%] which represent approximately half or double the prevalence of being non-heterosexual among boys without maltreatment experiences, respectively. The average marginal effect for Model 2 was not within the equivalence bounds, Z = -1.60, p = .055. Childhood parental maltreatment was not significantly associated with an increased odds of being non-heterosexual in girls in both models, p = .455 and p = .290, respectively.

The results of propensity score weighting showed that if all boys had experienced childhood parental maltreatment the prevalence of non-heterosexuality would have been expected to be increased by 3.54%, 95%CI = [0.38%, 6.71%], p = .028, compared to if no boys experienced maltreatment (Model 3). The effect was reduced to 2.86% after including GNCB in the propensity score construction in Model 4, p = .059 (Table 2). The effect for Model 4 was not within the equivalence bounds [-1.00%, 4.00%], Z = -0.75, p = .227. Childhood parental maltreatment was not significantly associated with an increased odds of being non-heterosexual in girls in both models, p = .491 and p = .255, respectively.

Discussion

This study found that boys with a history of childhood parental maltreatment were significantly more likely to be non-heterosexual even after controlling for important covariates. This association in logistic regression was reduced to non-significance with the addition of GNCB. For propensity score analysis, we estimated the prevalence of non-heterosexuality to be 3.54% if all boys experienced maltreatment (compared to if no

boys experienced maltreatment) and 2.86% after including GNCB. Childhood parental maltreatment did not increase the probability to being non-heterosexual in girls contrary to our hypotheses. Both logistic regression and propensity score analysis suggest that GNCB may help explain the relationship between childhood maltreatment and adolescent male sexual orientation. However, unlike standard logistic regression, propensity score analysis accounts for imbalances in covariates between exposed and comparison groups to replicate the properties of a randomized controlled experiment, which allows researchers to get closer to causal associations (Garrido et al., 2014). Propensity score analysis has been shown to produced less biased and more robust estimates than regressions in analyses with multiple covariates and rare events (e.g., non-heterosexuality here) (Joffe & Rosenbaum, 1999; Shah, Laupacis, Hux, & Austin, 2005). Thus, we focused on the results from propensity score analysis. Given that no associations were observed in girls in the present study, contrary to expectations that their sexual orientation would be more influenced by psychosocial factors, the results for boys should be considered in the context of discovery.

The simple association reported here was small in effect size and so is somewhat exploratory rather than definitive compared to earlier studies on the positive association between childhood maltreatment and sexual orientation (Friedman et al., 2011; Roberts et al., 2013). The findings suggest that the association between childhood maltreatment and male non-heterosexuality may at least partly be accounted for by GNCB. This supports the hypothesis that the greater levels of childhood gender nonconformity among non-heterosexual males may make them more vulnerable to maltreatment (Alanko et al., 2010; Xu & Zheng, 2017). It should be noted that although the effect of childhood maltreatment on sexual orientation was attenuated after including GNCB in the propensity score construction, the effect was not reduced to zero. Thus, there may remain some direct associations between childhood maltreatment and sexual orientation (albeit small in effect

size) or they may be accounted for by unmeasured confounders (see limitations below).

The exploratory findings for boys suggest that parents may be responding to GNCB itself with maltreatment (Bos et al., 2019). This may be because GNCB serves as a behavioral forecast of later non-heterosexuality or constitutes a violation of gender norms (Bos et al., 2019). GNCB among boys compared to girls is more socially stigmatized and less accepted by family members and peers (Langlois & Downs, 1980; Sandnabba & Ahlberg, 1999). Masculinity in girls may not trigger negative parental or cultural reactions as femininity does in boys. The results for girls do not support the notion that female sexual orientation is more influenced by certain psychosocial experiences (e.g., childhood parental maltreatment) compared to male sexual orientation. But they do not rule out other psychosocial experiences that might be important in the formation of female sexuality (Bailey et al., 2016). Theoretical models that lead to hypotheses regarding the greater involvement of psychosocial factors in female sexual orientation may require further refinement (Bailey et al., 2016).

The present study has particular strengths including a prospective design with childhood parental maltreatment and GNCB measured before sexual orientation, the use of a causal reference statistical method, good statistical power, and control over several important covariates also measured prospectively. These known covariates associated with risk of maltreatment included maternal anxiety and depression, family socioeconomic position, and home life disruption. The design reduced the risk of recall biases influencing the results and gets closer to a causal explanation for the associations reported in the propensity score analyses.

However, there are several limitations. Propensity score analysis cannot adjust for unmeasured additional variables between exposed and control groups. Thus, some unmeasured variables such as parents' awareness of children's sexual orientation and unmeasured family dynamics could influence the results (D'Augelli, Grossman, & Starks,

2005; Willoughby, Malik, & Lindahl, 2006). We could not control for important confounds such as shared genes between parents and children, or unmeasured genetic and environmental factors that load simultaneously on sexual orientation, GNCB, and maltreatment (Bailey et al., 2014). Maternal, rather than child, reports may underestimate the prevalence of maltreatment due to legal stricture. We focused on parental maltreatment, and items that measured physical and emotional maltreatment only. Maltreatment presence was very low and we could not discriminate the intensity of maltreatment. As we dichotomized maltreatment (using yes or no response for the first 4 waves and ordinal responses for the later waves), this may have contributed to lower rates of maltreatment. Also, we could not separate between maltreatment by mothers and fathers or other partners. The use of measures with restricted response categories is a common problem of using prospective birth cohorts despite their numerous other advantages. Maltreatment and GNCB were measured relatively early in childhood and so the effects of later child maltreatment may produce stronger associations.

The current study measured sexual orientation in adolescence. Age 15 appeared to be an appropriate age to begin measuring sexual orientation based on the psychometric properties of the 5-point measure used (Ott et al., 2011). However, measuring sexual orientation at later ages may produce different results given that the rate of non-heterosexuality increases from adolescent to young adulthood (Bailey et al., 2016). Adolescents may also misreport their sexual orientation (Savin-Williams & Joyner, 2014). Moreover, awareness of adolescent stage same-sex attractions might not necessarily be related to later (e.g., young adulthood) sexual orientation identities. Finally, the sample size of non-heterosexuals was small, especially for homosexual girls. Thus, small increases in the number of non-heterosexuals who experienced childhood maltreatment would result in larger odds ratios. Given the low population prevalence of non-heterosexuality (Bailey et al., 2016), small numbers of

non-heterosexuals in cohort studies are to be expected.

In sum, the present results suggest that a small prospective association between childhood parental maltreatment and later adolescent sexual orientation may be accounted for by greater childhood gender nonconformity among non-heterosexual males. These results appear to remain after controlling for several important covariates that predict childhood maltreatment and sexual orientation. Future studies should attempt to disentangle the possible role of third variables such as common genetic and environmental factors.

References

Alanko, K., Santtila, P., Harlaar, N., Witting, K., Varjonen, M., Jern, P., ... & Sandnabba, N. K. (2010). Common genetic effects of gender atypical behavior in childhood and sexual orientation in adulthood: A study of Finnish twins. *Archives of Sexual Behavior*, *39*, 81-92. https://doi.org/10.1007/s10508-008-9457-3

Bailey, D. H., & Bailey, J. M. (2013). Poor instruments lead to poor inferences: Comment on Roberts, Glymour, and Koenen (2013). *Archives of Sexual Behavior*, *42*, 1649-1652. https://doi.org/10.1007/s10508-013-0101-5

Bailey, D. H., Ellingson, J. M., & Bailey, J. M. (2014). Genetic confounds in the study of sexual orientation: Comment on Roberts, Glymour, and Koenen (2014). *Archives of Sexual Behavior*, *43*, 1675-1677. https://doi.org/10.1007/s10508-014-0269-3

Bailey, J. M., Vasey, P. L., Diamond, L. M., Breedlove, S. M., Vilain, E., & Epprecht, M. (2016). Sexual orientation, controversy, and science. *Psychological Science in the Public Interest*, *17*, 45–101. https://doi.org/10.1177/1529100616637616

Bailey, J. M., & Zucker, K. J. (1995). Childhood sex-typed behavior and sexual orientation: A conceptual analysis and quantitative review. *Developmental Psychology*, *31*, 43-55. http://dx.doi.org/10.1037/0012-1649.31.1.43

Barnett, B. E., Hanna, B., & Parker, G. (1983). Life event scales for obstetric groups. *Journal*

of Psychosomatic Research, *27*, 313-320. https://doi.org/10.1016/0022-3999(83)90054-5

Bell, A. P., Weinberg, M. S., & Hammersmith, S. K. (1981). *Sexual preference: Its development in men and women*. Bloomington: Indiana University Press.

Borenstein, M., Hedges, L. V., Higgins, J., & Rothstein, H. R. (2009). Converting among effect sizes. In M.Borenstein, L. V. Hedges, J. T. Higgins, & H. R. Rothstein (Eds.), *Introduction to meta-analysis* (pp. 45–49). Chichester, UK: John Wiley & Sons, Ltd.

Bos, H., de Haas, S., & Kuyper, L. (2019). Lesbian, gay, and bisexual adults: Childhood gender nonconformity, childhood trauma, and sexual victimization. *Journal of Interpersonal Violence*, *34*, 496-515. http://dx.doi.org/10.1177/0886260516641285.

Boyd, A., Golding, J., Macleod, J., Lawlor, D. A., Fraser, A., Henderson, J., ... & Davey Smith, G. (2013). Cohort profile: The 'children of the 90s'—the index offspring of the Avon Longitudinal Study of Parents and Children. *International Journal of Epidemiology*, *42*, 111-127. https://doi.org/10.1093/ije/dys064

Brown, G. W., & Harris, T. (1978). *Social origins of depression: A study of psychiatric disorder in women*. London: Tavistock Press

Calzo, J. P., Antonucci, T. C., Mays, V. M., & Cochran, S. D. (2011). Retrospective recall of sexual orientation identity development among gay, lesbian, and bisexual adults. *Developmental Psychology*, *47*, 1658-1673. http://dx.doi.org/10.1037/a0025508

Cepeda, M. S., Boston, R., Farrar, J. T., & Strom, B. L. (2003). Comparison of logistic regression versus propensity score when the number of events is low and there are multiple confounders. *American Journal of Epidemiology*, *158*, 280-287. https://doi.org/10.1093/aje/kwg115

Collishaw, S., Dunn, J., O'connor, T. G., Golding, J., & Avon Longitudinal Study of Parents and Children Study Team. (2007). Maternal childhood abuse and offspring adjustment

over time. *Development and Psychopathology*, *19*, 367-383. https://doi.org/10.1017/S0954579407070186

Corliss, H. L., Cochran, S. D., & Mays, V. M. (2002). Reports of parental maltreatment during childhood in a United States population-based survey of homosexual, bisexual, and heterosexual adults. *Child Abuse & Neglect*, *26*, 1165-1178. https://doi.org/10.1016/S0145-2134(02)00385-X

D'Augelli, A. R., Grossman, A. H., & Starks, M. T. (2005). Parents' awareness of lesbian, gay, and bisexual youths' sexual orientation. *Journal of Marriage and Family*, *67*, 474-482. https://doi.org/10.1111/j.0022-2445.2005.00129.x

D'Augelli, A. R., Grossman, A. H., & Starks, M. T. (2006). Childhood gender atypicality, victimization, and PTSD among lesbian, gay, and bisexual youth. *Journal of Interpersonal Violence*, *21*, 1462-1482. https://doi.org/10.1177/0886260506293482

Demidenko, E. (2007). Sample size determination for logistic regression revisited. *Statistics in Medicine*, *26*, 3385-3397. https://doi.org/10.1002/sim.2771

Feiveson, A. H. (2002). Power by simulation. The Stata Journal, 2, 107-124. https://doi.org/10.1177/1536867X0200200201

Fraser, A., Macdonald-Wallis, C., Tilling, K., Boyd, A., Golding, J., Davey Smith, G., ... & Ring, S. (2013). Cohort profile: the Avon Longitudinal Study of Parents and Children: ALSPAC mothers cohort. *International Journal of Epidemiology*, *42*, 97-110. https://doi.org/10.1093/ije/dys066

Friedman, M. S., Marshal, M. P., Guadamuz, T. E., Wei, C., Wong, C. F., Saewyc, E. M., & Stall, R. (2011). A meta-analysis of disparities in childhood sexual abuse, parental physical abuse, and peer victimization among sexual minority and sexual nonminority individuals. *American Journal of Public Health*, *101*, 1481-1494. https://doi.org/10.2105/AJPH.2009.190009

Garrido, M. M., Kelley, A. S., Paris, J., Roza, K., Meier, D. E., Morrison, R. S., & Aldridge, M. D. (2014). Methods for constructing and assessing propensity scores. *Health Services Research*, *49*, 1701-1720. https://doi.org/10.1111/1475-6773.12182

Golombok, S., & Rust, J. (1993). The measurement of gender role behaviour in pre-school children: A research note. *Journal of Child Psychology and Psychiatry*, *34*, 805-811. https://doi.org/10.1111/j.1469-7610.1993.tb01072.x

Honnor, M. J., Zubrick, S. R., & Stanley, F. J. (1994). The role of life events in different categories of preterm birth in a group of women with previous poor pregnancy outcome. *European Journal of Epidemiology*, *10*, 181-188. https://doi.org/10.1007/BF01730368

Joffe, M. M., & Rosenbaum, P. R. (1999). Invited commentary: Propensity scores. American *Journal of Epidemiology*, *150*, 327–333. http://dx.doi .org/10.1093/oxfordjournals.aje.a010011

Kane, E. W. (2006). "No way my boys are going to be like that!" Parents' responses to children's gender nonconformity. *Gender & Society*, *20*, 149-176. https://doi.org/10.1177/0891243205284276

Kleinke, K. (2017). Multiple imputation under violated distributional assumptions: A systematic evaluation of the assumed robustness of predictive mean matching. *Journal of Educational and Behavioral Statistics*, *42*, 371-404. https://doi.org/10.3102/1076998616687084

Landolt, M. A., Bartholomew, K., Saffrey, C., Oram, D., & Perlman, D. (2004). Gender nonconformity, childhood rejection, and adult attachment: A study of gay men. *Archives of Sexual Behavior*, *33*, 117-128.https://doi.org/10.1023/B:ASEB.0000014326.64934.50

Lakens, D. (2017). Equivalence tests: A practical primer for t tests, correlations, and meta-analyses. *Social Psychological and Personality Science*, *8*, 355-362.

https://doi.org/10.1177/1948550617697177

Langlois, J. H., & Downs, A. C. (1980). Mothers, fathers, and peers as socialization agents of sex-typed play behaviors in young children. *Child Development*, *51*, 1237-1247. http://dx.doi.org/10.2307/1129566

Lee, J., & Little, T. D. (2017). A practical guide to propensity score analysis for applied clinical research. *Behaviour Research and Therapy*, *98*, 76-90. https://doi.org/10.1016/j.brat.2017.01.005

Lereya, S. T., Copeland, W. E., Costello, E. J., & Wolke, D. (2015). Adult mental health consequences of peer bullying and maltreatment in childhood: Two cohorts in two countries. *The Lancet Psychiatry*, *2*, 524-531. https://doi.org/10.1016/S2215-0366(15)00165-0

LeVay, S. (1996). *Queer science: The use and abuse of research into homosexuality*. Cambridge, MA: MIT Press.

Li, G., Kung, K. T. F., & Hines, M. (2017). Childhood gender-typed behavior and adolescent sexual orientation: A longitudinal population-based study. *Developmental Psychology, 53*, 764-777. http://dx.doi.org/10.1037/dev0000281

Ott, M. Q., Corliss, H. L., Wypij, D., Rosario, M., & Austin, S. B. (2011). Stability and change in self-reported sexual orientation identity in young people: Application of mobility metrics. *Archives of Sexual Behavior*, *40*, 519-532. https://doi.org/10.1007/s10508-010-9691-3

Roberts, A. L., Austin, S. B., Corliss, H. L., Vandermorris, A. K., & Koenen, K. C. (2010). Pervasive trauma exposure among US sexual orientation minority adults and risk of posttraumatic stress disorder. *American Journal of Public Health*, *100*, 2433-2441. http://doi.org/ 10.2105/AJPH.2009.168971

Roberts, A. L., Glymour, M. M., & Koenen, K. C. (2013). Does maltreatment in childhood

affect sexual orientation in adulthood?. *Archives of Sexual Behavior*, *42*, 161-171. https://doi.org/10.1007/s10508-012-0021-9

Roberts, A. L., Rosario, M., Corliss, H. L., Koenen, K. C., & Austin, S. B. (2012a). Childhood gender nonconformity: A risk indicator for childhood abuse and posttraumatic stress in youth. *Pediatrics*, *129*, 410-417. http://doi.org/ 10.1542/peds.2011-1804

Roberts, A. L., Rosario, M., Corliss, H. L., Koenen, K. C., & Austin, S. B. (2012b). Elevated risk of posttraumatic stress in sexual minority youths: Mediation by childhood abuse and gender nonconformity. *American Journal of Public Health*, *102*, 1587-1593. http://doi.org/10.2105/AJPH.2011.300530

Roberts, A. L., Rosario, M., Slopen, N., Calzo, J. P., & Austin, S. B. (2013). Childhood gender nonconformity, bullying victimization, and depressive symptoms across adolescence and early adulthood: An 11-year longitudinal study. *Journal of the American Academy of Child & Adolescent Psychiatry*, *52*, 143-152. https://doi.org/10.1016/j.jaac.2012.11.006

Rubin, D.B. (2009). *Multiple imputation for nonresponse in surveys*. New York: Wiley.

Saewyc, E. M., Skay, C. L., Pettingell, S. L., & Reis, E. A. (2006). Hazards of stigma: The sexual and physical abuse of gay, lesbian, and bisexual adolescents in the United States and Canada. *Child Welfare*, *85*, 195-213.

Sandnabba, N. K., & Ahlberg, C. (1999). Parents' attitudes and expectations about children's cross-gender behavior. *Sex Roles*, 40, 249-263. https://doi.org/10.1023/A:1018851005631

Savin-Williams, R. C., & Joyner, K. (2014). The dubious assessment of gay, lesbian, and bisexual adolescents of Add Health. *Archives of Sexual Behavior*, *43*, 413-422. https://doi.org/10.1007/s10508-013-0219-5

Shah, B. R., Laupacis, A., Hux, J. E., & Austin, P. C. (2005). Propensity score methods gave similar results to traditional regression modeling in observational studies: A systematic review. *Journal of clinical epidemiology*, *58*, 550-559. https://doi.org/10.1016/j.jclinepi.2004.10.016

Sidebotham, P. (2000). Patterns of child abuse in early childhood, a cohort study of the 'Children of the Nineties'. *Child Abuse Review*, *9*, 311-320. https://doi.org/10.1002/1099-0852(200009/10)9:5<311::AID-CAR627>3.0.CO;2-U

Sidebotham, P., Golding, J., & ALSPAC Study Team. (2001). Child maltreatment in the "Children of the Nineties": A longitudinal study of parental risk factors. *Child Abuse & Neglect*, *25*, 1177-1200. https://doi.org/10.1016/S0145-2134(01)00261-7

Sweet, T., & Welles, S. L. (2012). Associations of sexual identity or same-sex behaviors with history of childhood sexual abuse and HIV/STI risk in the United States. *Journal of Acquired Immune Deficiency Syndromes*, *59*, 400-408. http://doi.org/ 10.1097/QAI.0b013e3182400e75

Steyerberg, E. W., Harrell Jr, F. E., Borsboom, G. J., Eijkemans, M. J. C., Vergouwe, Y., & Habbema, J. D. F. (2001). Internal validation of predictive models: Efficiency of some procedures for logistic regression analysis. *Journal of Clinical Epidemiology*, *54*, 774-781. https://doi.org/10.1016/S0895-4356(01)00341-9

Toomey, R. B., Ryan, C., Diaz, R. M., Card, N. A., & Russell, S. T. (2010). Gender-nonconforming lesbian, gay, bisexual, and transgender youth: School victimization and young adult psychosocial adjustment. *Developmental Psychology*, *46*, 1580-1589. http://dx.doi.org/10.1037/a0020705

Vink, G., Frank, L. E., Pannekoek, J., & Van Buuren, S. (2014). Predictive mean matching imputation of semicontinuous variables. *Statistica Neerlandica*, *68*, 61-90. https://doi.org/10.1111/stan.12023

Watts, T. M., Holmes, L., Raines, J., Orbell, S., & Rieger, G. (2018). Gender nonconformity of identical twins with discordant sexual orientations: Evidence from childhood photographs. *Developmental Psychology*, *54*, 788-801. http://dx.doi.org/10.1037/dev0000461

White, I. R., Royston, P., & Wood, A. M. (2011). Multiple imputation using chained equations: Issues and guidance for practice. *Statistics in Medicine*, *30*, 377-399. https://doi.org/10.1002/sim.4067

Willoughby, B. L., Malik, N. M., & Lindahl, K. M. (2006). Parental reactions to their sons' sexual orientation disclosures: The roles of family cohesion, adaptability, and parenting style. *Psychology of Men & Masculinity*, *7*, 14-26. http://dx.doi.org/10.1037/1524-9220.7.1.14

Xu, Y., Norton, S., & Rahman, Q. (2018). Early life conditions, reproductive and sexuality-related life history outcomes among human males: A systematic review and meta-analysis. *Evolution and Human Behavior*, *39*, 40-51. https://doi.org/10.1016/j.evolhumbehav.2017.08.005

Xu, Y., & Zheng, Y. (2017). Does sexual orientation precede childhood sexual abuse? Childhood gender nonconformity as a risk factor and instrumental variable analysis. *Sexual Abuse*, *29*, 786-802. https://doi.org/10.1177/1079063215618378

Table 1

Descriptive Statistics of Key Variables Separately by Sex.

	Boys		Girls	
	Heterosexual	Non-heterosexual	Heterosexual	Non-heterosexual
Childhood gender nonconforming behavior				
N	1706	46	1857	47
M (*SD*)	61.93 (7.28)	55.36 (9.14)	37.50 (7.74)	42.87 (9.68)
Childhood parental maltreatment before teenagers were 7 years *N* (%)				
Yes	271 (12.10)	15 (25.86)	305 (12.19)	9 (13.24)
No	1968 (87.90)	43 (74.14)	2198 (87.81)	59 (86.76)

Note: The range for childhood gender nonconforming behavior is from -4.55 to 101.05, with a higher score indicating more male-typical behavior and less female-typical behavior for girls and boys.

Table 2

Results from Logistic Regression (Marginal Effects) and Propensity Score Analysis (Average Treatment Effects).

		Model 1	Model 2	Model 3	Model 4
Sex	Childhood parental maltreatment (ref = no)	Non-heterosexual	Non-heterosexual	Non-heterosexual	Non-heterosexual
Boys	Maltreated	3.00%* [0.27%, 5.74%]	2.06% [-0.32%, 4.44%]	3.54%* [0.38%, 6.71%]	2.86% [-0.11%, 5.84%]
Girls	Maltreated	-0.68% [-2.34%, 0.98%]	-0.94% [-2.49%, 0.61%]	-0.70% [-2.54%, 1.14%]	-1.08% [-2.68%, 0.51%]

Note: Model 1 is logistic regression that controlled for all covariates except GNCB, and Model 2 is the same with GNCB being further controlled. Model 3 is propensity score weighted analysis using all covariates except GNCB, and Model 4 is the same with GNCB being additionally included in the propensity score construction. For boys, Model 1 and Model 3 controlled for right-hand 2D:4D, birthweight, parental absence, duration of breastfeeding, and number of house moves since teenagers were 7 years. For girls, Model 1 and Model 3 controlled for prenatal family socioeconomic position, parental absence, and parent-child relationship.

[a]Heterosexual boys or girls are the reference group.

*$p < .05$.

Supplemental Text 1

Auxiliary variable

Sexual behavior

When adolescents were 15.5 years old, they were required to report whether they have engaged in fourteen sexual activities from the Adolescent Sexual Activities Index (Hansen, Paskett, & Carter, 1999). Those sexual activities were presented in order from low (e.g., hug or hold hand) to high (e.g., have oral sex or have sexual intercourse) intensity. Adolescents were required to report whether they had engaged in each sexual activities in the past year, and the sex of the person with whom they engaged in each sexual activities. Adolescents who reported not happened received a score of 0 on that activity, those who reported engaging in the activity with opposite sex received a score of 1 on that activity, and those who reported engaging in the activity with the same sex or both sexes received a score of 2 on that activity. The total score was used in the multiple imputation, with a higher score indicating more same-sex sexual activities.

Details about covariates

Body size

The birthweights of adolescents were abstracted from the birth notification and/or obstetric data and/or recorded by the ALSPAC measurers in the delivery room. For data recorded via more than one measurement method, the ALSPAC team used the following criteria. If the birthweight values from each measurement method were identical, then the value was accepted; if the disagreement between birthweight values from different measurement methods was less than 100 grams, then the lowest value was accepted; if the disagreement between birthweight values from different measurement methods was greater than 100 grams, then the value was coded as missing data. Birthweight was coded in kilograms.

When adolescents were 14 years and 7 months old, they report their height and weight. Body mass index (BMI) was calculated as weight divided by height squared.

Gestational age

Gestational age was recorded based on the date of the mother's last menstrual period, paediatric or obstetric assessment, and ultrasound assessment. Adolescents were categorized into three gestational age groups: preterm birth (< 37 weeks' gestational age), term birth (37 - 41 weeks' gestational age), and postterm birth (> 41 weeks' gestational age) (Savitz et al., 2002).

Parental age

Maternal age was recorded as the age at the last menstrual period. When adolescents were 12 weeks' gestation, partners of adolescents' mothers were required to report whether they are the fathers of their partner's unborn child. If they reported "yes", the age of partner at completion of questionnaire was coded as paternal age; otherwise, the paternal age was coded as missing data.

Maternal anxiety and depression

When adolescents were 18 weeks' gestation and 8 weeks old, two subscales of Crown-Crisp Experiential Index were used to measure maternal anxiety and depression. The Crown-Crisp Experiential Index is a validated self-report inventory (Ross & Hafner, 1990). Each subscale consists of 8 items rated on a 4-point scale ranging from 1 = *never* to 4 = *very often*. An example item is "Do you worry a lot?" We used the age of zero as a cut-off to recode those into four variables: prenatal maternal anxiety/depression and postnatal maternal anxiety/depression. Since prenatal maternal anxiety and depression were correlated (r = .77), the average of prenatal maternal anxiety and depression was used in the analysis. Similarly, postnatal maternal anxiety and depression were also correlated (r = .73), and the average of postnatal maternal anxiety and depression was used in the analysis

Older siblings

When adolescents were 6 months old, their mothers were required to report the numbers of older brothers and sisters who lived with the adolescents, including half-brothers and half-sisters, step brothers and step-sisters, fostered children, and adopted children.

Duration of breastfeeding

When adolescents were 1 years and 3 months old, their mothers were required to report whether their children were breast fed and the duration of breastfeeding in months. Duration of breastfeeding in months were used in the analysis, and adolescents who were not breast fed received a score of 0 on this variable.

Parental absence

When adolescents were 1 year 9 months, 2 years 9 months, 3 years 11 months, 7 years 1 month, 8 years 1 month, and 10 years 2 months old, their mothers were required to answer the questions: "Is the present live-in father-figure/mother-figure the biological father/mother of the study child?" and "How old was the child when the biological father/mother stopped living with the child?". Studies have suggested that the first five to seven years of life may constitute a sensitive period for the influence of family structure change on life history development (Xu, Norton, & Rahman, 2018). Accordingly, father absence and mother absence were recoded into two variables (father absence and mother absence) with four categories: never with father/mother, father/mother absence before 7 years old, father/mother absence since 7 years old, and father/mother present.

House move times

When adolescents were 8 months, 1 year 9 months, 2 years 9 months, 5 years 1 month, 7 years 1 month, and 10 years 2 months old, their mothers were required to report how many times they have moved home since last interview. We used the age of seven as a cut-off to

recode those into two variables: the total house moves before adolescents were 7 years old, and since 7 years old.

Parent-child relationship

When adolescents were 9 years 7 months old, they were asked to rate their relationship with their parents on a 9-item, 5- point scales ranging from 1 = *not true* to 5 = *true*. Example items include "I have a parent who I have a lot of fun with" and "I have a parent I get along well with".

Family socioeconomic position

Family socioeconomic position was assessed using several indicators including parents' education, parents' occupation, family financial difficulties, and household income. When adolescents were 32 weeks gestation, their mothers were required to report their own and their partner's highest educational qualifications (*CSE*, *vocational*, *O level*, *A level*, *and Degree*).

When adolescents were 18 weeks gestation, 32 weeks gestation, 8 months, 1 year and 9 months, 2 years 9 months, and 3 years 11 months old, their mothers were required to report their own occupation. When adolescents were 12 weeks gestation, 18 weeks gestation, 8 months, 21 months, and 8 years 1 month, their mothers' partners were required to report their occupation. The Standard Occupational Classification 2000 was used to measure mothers' and their partners' occupations. We used the age of seven as a cut-off to recode those into 4 variables, mother's lowest occupation before adolescents were born, mother's partner's lowest occupation before adolescents were born, mother's lowest occupation before adolescents were 7 years old, and mother's partner's lowest occupation before adolescents were 7 years old.

When adolescents were 2 years 9 months, 3 years 11 months, 7 years 1 month, and 8 years 1 month old, their mothers were required to answer the question: "On average, about

how much is the take home family income each weak?" Mothers were required to choose from *Less than £100*, *£100 - £199*, *£200 - £299*, *£300 - £399*, *£400 or more*, and *Don't know*. We used the age of seven as a cut-off to recode those into 2 variables, lowest family income before adolescents were born, and lowest family income before adolescents were 7 years old.

When adolescents were 32 weeks gestation, 8 months, 2 years 9 months**,** 5 years 1 month, 7 years 1 month, and 11 years 2 months old, their mothers were required to answer 5 questions regarding how difficult at the moment do they find it to afford various items (e.g., food, clothing, and heating) on a 4-point scale ranging from 0 = *not difficult* to 3 = *very difficult*. We used the age of seven as a cut-off to recode those into 3 variables: the worst family financial difficulties before adolescents were born, the worst family financial difficulties before adolescents were 7 years old, and the worst family financial difficulties since adolescents were 7 years old.

Since these indicators of family socioeconomic position are correlated (with a polychoric correlation ranging from .19 to .63), prenatal family socioeconomic position, family socioeconomic position before adolescents were 7 years old, and family socioeconomic position since adolescents were 7 years old were constructed. We applied polychoric principal component analysis, and used the factor loadings on the first principal component as item weightings to generate a summary score for prenatal family socioeconomic position, family socioeconomic position before adolescents were 7 years old, and family socioeconomic position since adolescents were 7 years old (Spriggs, Halpern, Herring, & Schoenbach, 2009; Vyas & Kumaranayake, 2006). A higher score indicates lower family socioeconomic position. The first component could explain 49.20%, 50.27%, and 55.32% of the variation in the prenatal family socioeconomic position, family socioeconomic position before adolescents were 7 years old, and family socioeconomic position since adolescents were 7 years old, respectively.

Digit ratio (2D: 4D)

When adolescents were 11 years old, photocopies of adolescents' hands were taken. They are required to place the ventral surface of both hands flat onto the photocopier, and the lengths of the second and the fourth digits for each hand were measured accurate to 0.01mm using the "Mahr digital caliper16 EX". The digit ratio (2D:4D) is calculated as the ratio of the lengths of the second digit to the fourth digit. Digit ratio is a measure ascribed to the prenatal actions of androgens, and thus claimed to serve as a window on prenatal androgen influences upon behavioral traits of interest (especially those linked to sex and sexuality). Digit ratio is associated more strongly with female than male sexual orientation (Grimbos, Dawood, Burriss, Zucker, & Puts, 2010).

Handedness

When adolescents were 9 year 7 months old, they were required to choose which hand they prefer to use for 6 activities (e.g., Which hand to you draw) from1 = *Left*, *2 = Either*, 3 = *right*, and 4 = *Do not do this at all*. Adolescents who chose *Do not do this at all* were coded as missing information. The total score for the six items was coded and a higher score indicates right-handedness.

References

Grimbos, T., Dawood, K., Burriss, R. P., Zucker, K. J., & Puts, D. A. (2010). Sexual orientation and the second to fourth finger length ratio: A meta-analysis in men and women. *Behavioral Neuroscience*, *124*, 278-287.

Hansen, W. B., Paskett, E. D., & Carter, L. J. (1999). The Adolescent Sexual Activity Index (ASAI): A standardized strategy for measuring interpersonal heterosexual behaviors among youth. *Health Education Research*, *14*, 485-490.

Ross, M. W., & Hafner, R. J. (1990). A comparison of the factor structure of the Crown-Crisp Experiential Index across sex and psychiatric status. *Personality and Individual Differences*, *11*, 733-739.

Savitz, D. A., Terry Jr, J. W., Dole, N., Thorp Jr, J. M., Siega-Riz, A. M., & Herring, A. H. (2002). Comparison of pregnancy dating by last menstrual period, ultrasound scanning, and their combination. *American Journal of Obstetrics and Gynecology*, *187*, 1660-1666.

Spriggs, A. L., Halpern, C. T., Herring, A. H., & Schoenbach, V. J. (2009). Family and school socioeconomic disadvantage: Interactive influences on adolescent dating violence victimization. *Social Science & Medicine*, *68*, 1956-1965.

Vyas, S., & Kumaranayake, L. (2006). Constructing socio-economic status indices: How to use principal components analysis. *Health Policy and Planning*, *21*, 459-468.

Xu, Y., Norton, S., & Rahman, Q. (2018). Early life conditions, reproductive and sexuality-related life history outcomes among human males: A systematic review and meta-analysis. *Evolution and Human Behavior*, *39*, 40-51.

Supplemental Text 2

Sexual Orientation and Childhood Parental Maltreatment

Childhood parental maltreatment was experienced by 12.10% of heterosexual boys, 20.69% of bisexual boys, 31.03% of homosexual boys, 12.19% of heterosexual girls, and 15.69% of bisexual girls in our sample. Homosexual boys were significantly more likely to be maltreated by their parents in childhood than their heterosexual counterparts, odds ratio = 3.20, 95% confidence interval (CI) = [1.44, 7.09], $p = .004$. Bisexual boys also had a greater odds of being maltreated by their parents in childhood compared to heterosexual boys, though the difference was not significant, odds ratio = 1.89, 95%CI = [0.76, 4.68], $p = .169$. Similarly, increased odds but with no significant difference were observed between bisexual and homosexual boys, odds ratio = 1.69, 95%CI = [0.51, 5.58], $p = .388$ and between heterosexual and bisexual girls, odds ratio = 1.31, 95%CI = [0.61, 2.82], $p = .493$. While decreased odds but with no significant difference were observed between heterosexual and homosexual girls, odds ratio = 0.45, 95%CI = [0.06, 3.38], $p = .435$ and between bisexual and homosexual girls, odds ratio = 0.34, 95%CI = [0.04, 2.95], $p = .329$.

Sexual Orientation and GNCB

Boys and girls who displayed more GNCB were significantly more likely to be bisexual (risk ratio = 1.09, 95%CI = [1.04, 1.15], $p = .001$ and risk ratio = 1.06, 95%CI = [1.02, 1.10], $p = .001$ for boys and girls respectively) or homosexual (risk ratio =1.13, 95%CI = [1.07, 1.19], $p < .001$ and risk ratio = 1.11, 95%CI = [1.04, 1.18], $p = .001$ for boys and girls respectively). Compared to bisexuals, GNCB did not significantly increase the odds of being homosexual in either sex, risk ratio =1.04, 95%CI = [0.97, 1.11], $p = .311$ and risk ratio = 1.04, 95%CI = [0.97, 1.12], $p = .217$ for boys and girls respectively. Boys and girls who displayed more GNCB were also significantly more likely to have increased childhood

parental maltreatment, odds ratio = 1.02, 95%CI = [1.01, 1.04], p = .010 and odds ratio = 1.02, 95%CI = [1.00, 1.03], p = .017 for boys and girls respectively.

Supplemental Table 1. Descriptive Statistics for Covariates among Boys.

Variable	Sexual orientation		Missingness (%)
	Heterosexual	Non-heterosexual	
Birthweight (in kilograms)			6.03
N	2159	54	
M (*SD*)	3.47 (0.59)	3.24 (0.57)	
Pubertal body mass index			46.79
N	1277	26	
M (*SD*)	20.21 (2.98)	20.71 (4.05)	
Gestational age (*N*)			4.75
Preterm birth	131	-	
Term birth	1887	48	
Post-term birth	168	-	
Maternal age (in years)			4.75
N	2186	55	
M (*SD*)	28.59 (4.55)	27.84 (4.21)	
Paternal age (in years)			31.84
N	1571	37	
M (*SD*)	31.53 (5.41)	30.92 (6.10)	
Prenatal maternal depression/anxiety[a]			19.93
N	1867	49	
M (*SD*)	4.50 (2.72)	4.95 (2.91)	
Postnatal maternal depression/anxiety[a]			12.44
N	1989	50	
M (*SD*)	3.24 (2.78)	3.62 (3.24)	
Number of older brothers			7.11
N	2138	57	
M (*SD*)	0.38 (0.62)	0.33 (0.55)	
Number of old sisters			7.35
N	2123	56	
M (*SD*)	0.36 (0.61)	0.32 (0.58)	
Duration of breastfeeding (in months)			26.94
N	1704	43	
M (*SD*)	6.07 (4.71)	4.37 (4.30)	
Father absence (*N*)			13.00
Never with father	54	-	
Father absence before adolescents were 7	192	9	
Father absence since adolescents were 7	64	-	
Father presence	1706	36	
Mother absence (*N*)			13.46
Never with mother	-	-	
Mother absence before adolescents were 7	-	-	
Mother absence since adolescents were 7	-	-	
Mother presence	2002	50	
Number of house moves before adolescents were 7			35.83
N	1498	39	
M (*SD*)	1.06 (1.44)	1.23 (1.60)	
Number of house moves since adolescents were 7			14.86
N	1984	49	
M (*SD*)	0.32 (0.59)	0.53 (0.77)	

Variable	Sexual orientation		Missingness (%)
	Heterosexual	Non-heterosexual	
Parent-child relationship[b]			20.77
N	1790	44	
M (*SD*)	41.30 (4.46)	40.61 (6.27)	
Prenatal family socioeconomic position[c]			29.54
N	1618	40	
M (*SD*)	4.84 (2.72)	5.45 (2.60)	
Family socioeconomic position before adolescents were 7[d]			56.80
N	1007	28	
M (*SD*)	5.08 (2.70)	5.09 (2.92)	
Family socioeconomic position since adolescents were 7[e]			31.84
N	1588	39	
M (*SD*)	2.73 (1.98)	3.15 (2.16)	
Left 2D:4D			8.17
N	2128	51	
M (*SD*)	0.96 (0.03)	0.97 (0.03)	
Right 2D:4D			8.13
N	2125	52	
M (*SD*)	0.96 (0.03)	0.98 (0.03)	
Handedness			17.20
N	1882	45	
M (*SD*)	15.85 (3.13)	16.24 (2.39)	

Note: "-" means 5 or less. Cell counts 5 or less are not presented in order to comply with ALSPAC publication requirements.

[a]The range is from 0 to 16.
[b]The range is from 9 to 45.
[c]The range is from 0 to 15.32.
[d]The range is from 0 to 16.40.
[e]The range is from 0 to 12.25.

Supplemental Table 2. Descriptive Statistics for Covariates among Girls.

Variable	Sexual orientation		Missingness (%)
	Heterosexual	Non-heterosexual	
Birthweight (in kilograms)			6.03
N	2423	69	
M (*SD*)	3.37 (0.50)	3.43 (0.43)	
Pubertal body mass index			46.79
N	1334	27	
M (*SD*)	20.83 (3.36)	22.26 (4.07)	
Gestational age (*N*)			4.75
Preterm birth	96	-	
Term birth	2185	64	
Post-term birth	178	-	
Maternal age (in years)			4.75
N	2459	69	
M (*SD*)	28.37 (4.52)	28.72 (5.56)	
Paternal age (in years)			31.84
N	1758	47	
M (*SD*)	31.22 (5.41)	31.77 (5.61)	
Prenatal maternal depression/anxiety[a]			19.93
N	2042	51	
M (*SD*)	4.50 (2.74)	5.10 (2.91)	
Postnatal maternal depression/anxiety[a]			12.44
N	2287	58	
M (*SD*)	3.27 (2.74)	3.67 (3.22)	
Number of older brothers			7.11
N	2391	65	
M (*SD*)	0.38 (0.63)	0.38 (0.68)	
Number of old sisters			7.35
N	2395	65	
M (*SD*)	0.37 (0.60)	0.32 (0.69)	
Duration of breastfeeding (in months)			26.94
N	1859	52	
M (*SD*)	6.36 (4.75)	7.17 (5.21)	
Father absence (*N*)			13.00
Never with father	62	-	
Father absence before adolescents were 7	239	12	
Father absence since adolescents were 7	53	-	
Father presence	1879	37	
Mother absence (*N*)			13.46
Never with mother	-	-	
Mother absence before adolescents were 7	-	-	
Mother absence since adolescents were 7	-	-	
Mother presence	2215	55	
Number of house moves before adolescents were 7			35.83
N	1637	39	
M (*SD*)	1.14 (1.47)	1.33 (1.66)	
Number of house moves since adolescents were 7			14.86
N	2177	53	
M (*SD*)	0.33 (0.72)	0.47 (1.03)	

Variable	Sexual orientation		Missingness (%)
	Heterosexual	Non-heterosexual	
Parent-child relationship[b]			20.77
N	2085	48	
M (*SD*)	42.22 (3.77)	40.52 (4.74)	
Prenatal family socioeconomic position[c]			29.54
N	1824	46	
M (*SD*)	4.93 (2.73)	5.85 (2.81)	
Family socioeconomic position before adolescents were 7[d]			56.80
N	1101	27	
M (*SD*)	5.21 (2.80)	5.45 (2.36)	
Family socioeconomic position since adolescents were 7[e]			31.84
N	1745	41	
M (*SD*)	2.84 (2.04)	2.99 (1.88)	
Left 2D:4D			8.17
N	2355	64	
M (*SD*)	0.97 (0.03)	0.97 (0.02)	
Right 2D:4D			8.13
N	2359	64	
M (*SD*)	0.97 (0.03)	0.97 (0.03)	
Handedness			17.20
N	2172	47	
M (*SD*)	15.93 (2.84)	15.57 (2.92)	

Note: "-" means 5 or less. Cell counts 5 or less are not presented in order to comply with ALSPAC publication requirements.

[a]The range is from 0 to 16.

[b]The range is from 9 to 45.

[c]The range is from 0 to 15.32.

[d]The range is from 0 to 16.40.

[e]The range is from 0 to 12.25.

Supplemental Table 3. Univariate Logistic Regressions for Childhood Parental Maltreatment and Sexual Orientation Separately by Sex

	Childhood parental maltreatment		Sexual orientation	Sexual orientation
Covariates	Boys	Girls	Non-heterosexual boys	Non-heterosexual girls
Gestational age (Ref = term birth)				
Preterm birth	1.305	0.524	0.934	0.703
Post-term birth	0.857	0.798	0.948	0.564
Birthweight (kilograms)	1.054	1.073	0.571**	1.224
Maternal age	1.043**	1.023	0.967	1.017
Paternal age	1.034**	1.012	0.980	1.013
Prenatal family socioeconomic position	1.033	1.070**	1.055	1.110*
Number of older brothers	1.291**	1.178	0.896	1.029
Number of older sisters	1.387**	1.354**	0.885	0.866
Prenatal maternal anxiety/depression	1.234***	1.236***	1.058	1.076
Childhood gender nonconforming behavior	0.977*	1.019*	0.900***	1.073***
Handedness	0.987	0.963	1.043	0.965
Left-hand 2D:4D	0.963	1.000	1.074	1.019
Right-hand 2D:4D	0.954*	0.989	1.177***	0.981
Parental absence (Ref = both parents presence)				
Never with mother or father	3.249***	3.014***	2.925*	2.369
Either parent absence before 7 years	4.161***	4.930***	2.157*	2.748**
Either parent absence since 7 years	2.096*	2.069*	1.288	4.112**
Duration of breastfeeding before 7 years	1.027	1.007	0.921*	1.039
Postnatal maternal anxiety/depression	1.210***	1.229***	1.045	1.056
Number of house moves before 7 years	1.015	1.070	1.058	1.053
Family socioeconomic position before 7 years	1.021	1.075**	1.007	1.063
Number of house moves since 7 years	1.014	1.152	1.520*	1.172
Parent-child relationship	0.981	0.963*	0.976	0.926**
Pubertal body mass index	1.042	0.993	1.043	1.084
Family socioeconomic position since 7 years	1.125***	1.191***	1.084	1.070

Note: For childhood parental maltreatment, boys/girls who did not experience childhood parental maltreatment are the reference group; for sexual orientation, heterosexual boys/girls are the reference group. The pooled estimates which were combined across 57 imputed datasets using Rubin's rule were reported here. For both prenatal and postnatal maternal anxiety/depression, a higher score indicating greater maternal

anxiety/depression. For parent-child relationship, a higher score indicating a better relationship with parents. For family socioeconomic position, a higher score indicates lower family SEP. For gender nonconforming behavior, a higher score indicates more male-typical behavior and less female-typical behavior for both girls and boys.
*$p < .05$; **$p < .01$; ***$p < .001$

Supplement Table 4. Balance of Covariates between Treatment and Control Groups after Weighting among Boys in Model 3 and 4

		Mean (SD)		Standardized difference
		Control group	Treatment group	
Model 3	Right-hand 2D: 4D	0.96 (0.02)	0.96 (0.05)	-0.04 (0.01)
	Birthweight	3.46 (0.00)	3.47 (0.01)	0.00 (0.01)
	Duration of breastfeeding before 7 years	5.94 (0.05)	5.98 (0.08)	0.01 (0.01)
	Number of house moves since 7 years	0.33 (0.00)	0.34 (0.01)	0.02 (0.02)
	Parental absence			
	Never with mother or father	0.03 (0.00)	0.03 (0.00)	0.00 (0.00)
	Either parent absence before 7 years	0.10 (0.00)	0.10 (0.00)	0.01 (0.00)
	Either parent absence since 7 years	0.03 (0.00)	0.03 (0.00)	0.00 (0.00)
	With both parents	0.83 (0.00)	0.83 (0.00)	-0.01 (0.00)
Model 4	Right-hand 2D: 4D	0.96 (0.02)	0.96 (0.06)	-0.04 (0.02)
	Birthweight	3.46 (0.00)	3.46 (0.01)	0.00 (0.01)
	Duration of breastfeeding before 7 years	5.95 (0.05)	6.01 (0.09)	0.01 (0.01)
	Number of house moves since 7 years	0.33 (0.00)	0.35 (0.01)	0.03 (0.02)
	Parental absence			
	Never with mother or father	0.03 (0.00)	0.03 (0.00)	-0.00 (0.00)
	Either parent absence before 7 years	0.10 (0.00)	0.10 (0.00)	-0.00 (0.00)
	Either parent absence since 7 years	0.03 (0.00)	0.03 (0.00)	-0.01 (0.00)
	With both parents	0.84 (0.00)	0.84 (0.00)	0.01 (0.01)
	Childhood gender nonconforming behavior	61.59 (0.05)	62.14 (0.12)	0.07 (0.01)

Note: Boys with no history of childhood parental maltreatment were the control group and boys with history of childhood parental maltreatment were the treatment group. The average of mean (*sd*) and standardized difference were calculated across 57 imputed datasets.

Supplemental Table 5 Balance of Covariates between Treatment and Control Groups after Weighting among Girls in Model 3 and 4

Model	Covariates	Mean (SD)		Standardized difference
		Control group	Treatment group	
Model 3	Prenatal family socioeconomic position	5.20 (0.03)	5.18 (0.05)	-0.01 (0.01)
	Parent-child relationship	42.16 (0.03)	42.08 (0.04)	-0.02 (0.01)
	Parental absence			
	Never with mother or father	0.03 (0.00)	0.03 (0.00)	0.00 (0.00)
	Either parent absence before 7 years	0.11 (0.00)	0.11 (0.00)	0.00 (0.00)
	Either parent absence since 7 years	0.03 (0.00)	0.03 (0.00)	0.00 (0.00)
	With both parents	0.83 (0.00)	0.83 (0.00)	-0.00 (0.00)
Model 4	Prenatal family socioeconomic position	5.20 (0.03)	5.17 (0.05)	-0.01 (0.01)
	Parent-child relationship	42.16 (0.03)	42.06 (0.05)	-0.02 (0.01)
	Parental absence			
	Never with mother or father	0.03 (0.00)	0.03 (0.00)	0.00 (0.00)
	Either parent absence before 7 years	0.11 (0.00)	0.11 (0.00)	-0.00 (0.00)
	Either parent absence since 7 years	0.03 (0.00)	0.03 (0.00)	-0.00 (0.00)
	With both parents	0.83 (0.00)	0.83 (0.00)	-0.00 (0.00)
	Childhood gender nonconforming behavior	37.67 (0.05)	37.54 (0.11)	-0.02 (0.01)

Note: Girls with no history of childhood parental maltreatment were the control group and girls with history of childhood parental maltreatment were the treatment group. The average of mean (*sd*) and standardized difference were calculated across 57 imputed datasets.

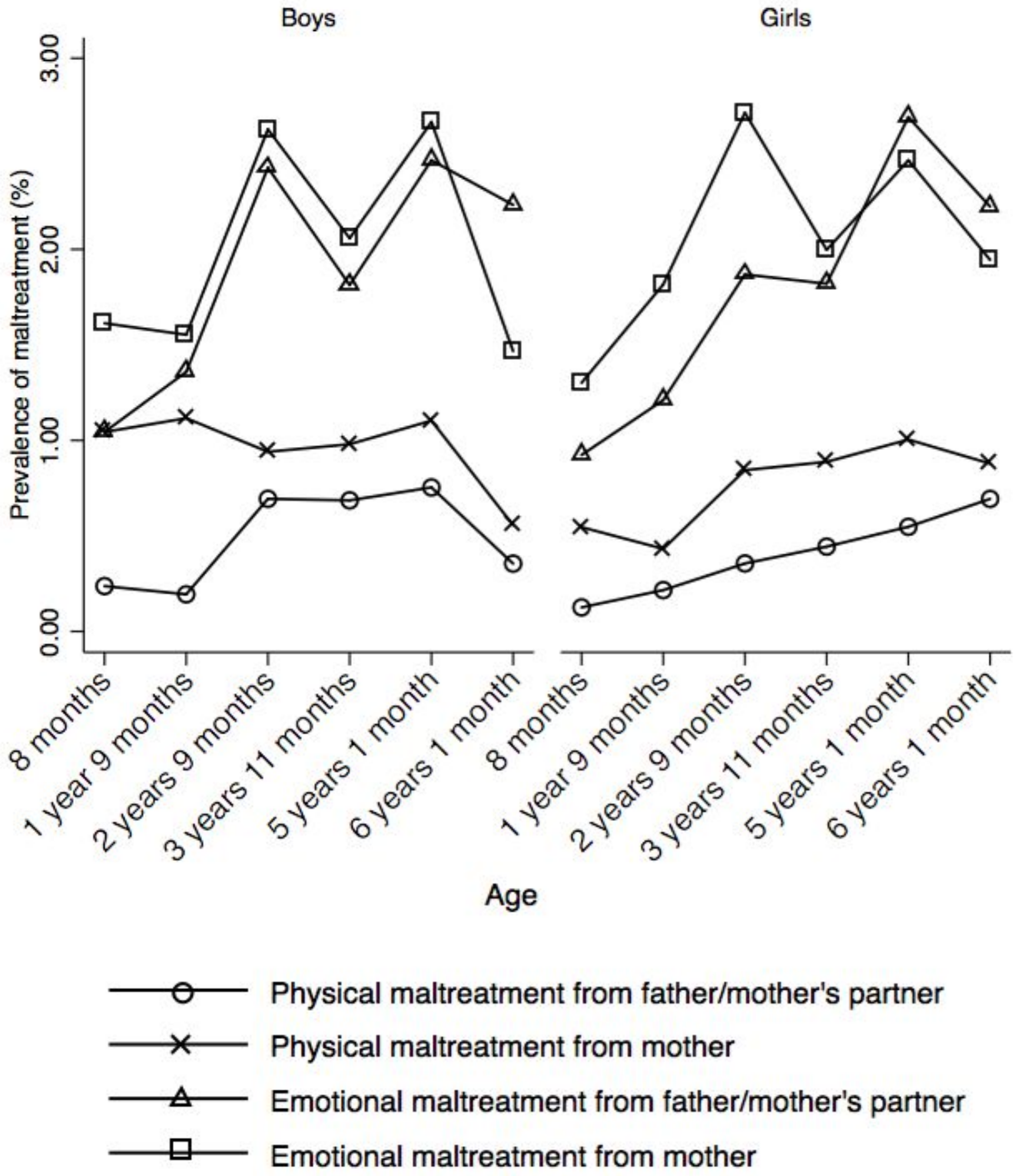
Supplemental Table 6. Results of Logistic Regression and Propensity Score Analysis for Sexual Orientation Separately by Sex.

		Model 1	Model 2	Model 3	Model 4
Sex	Childhood parental maltreatment (ref = no)	Odds ratio	Odds ratio	Odds ratio	Odds ratio
Boys	Maltreated	2.55** [1.33, 4.88]	2.06* [1.04, 4.07]	2.76** [1.41, 5.39]	2.38* [1.18, 4.81]
Girls	Maltreated	0.75 [0.35, 1.60]	0.66 [0.31, 1.42]	0.74 [0.32, 1.72]	0.62 [0.27, 1.42]

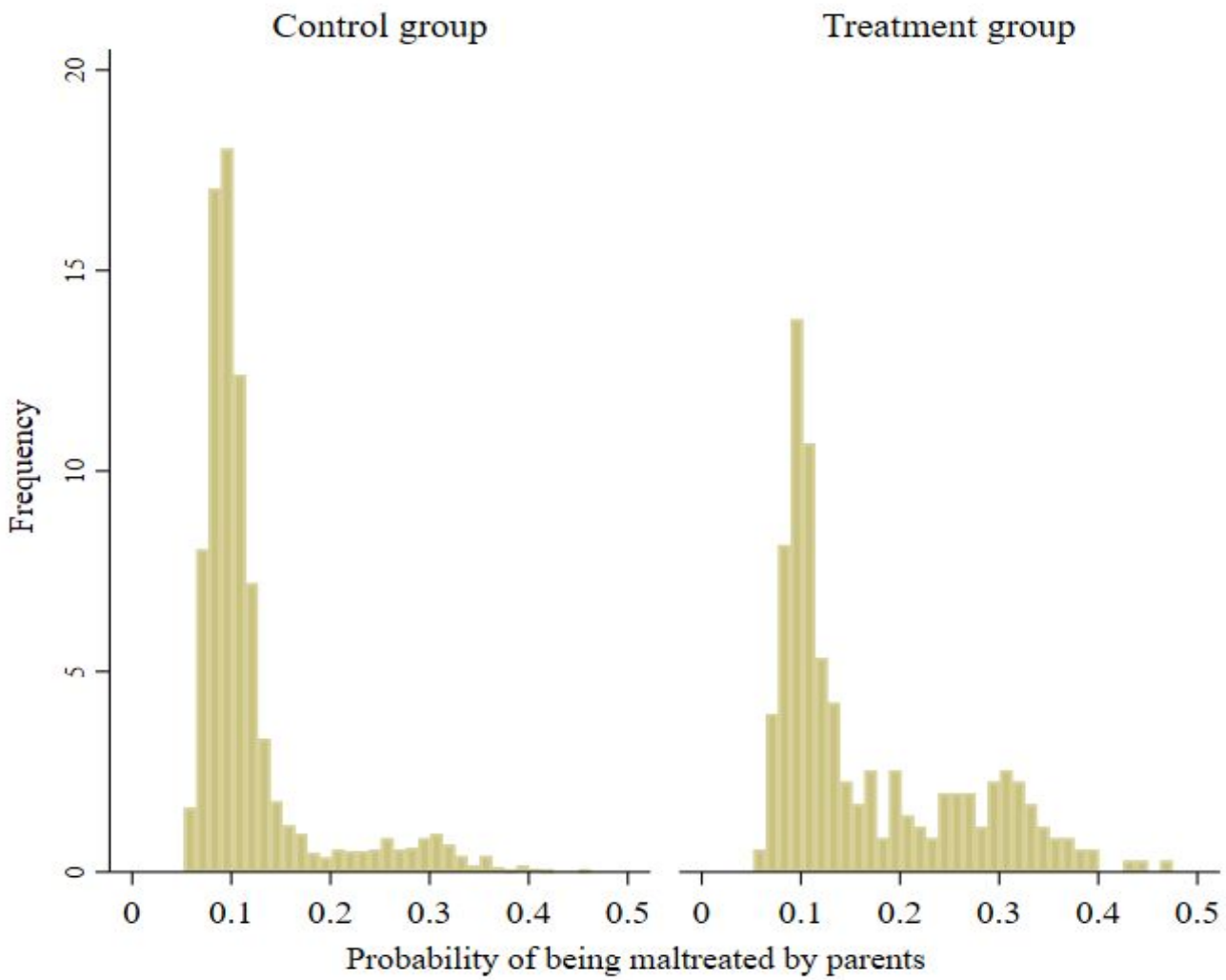
Note: Model 1 is logistic regression that controlled for all covariates except GNCB, and Model 2 is the same with GNCB being further controlled. Model 3 is propensity score weighted analysis where the propensity score is constructed using all covariates except GNCB, and Model 4 is the same with GNCB being additionally included in the propensity score construction. For boys, Model 1 and Model 3 controlled for right-hand 2D:4D, birthweight, parental absence, duration of breastfeeding, and number of house moves since teenagers were 7 years. For girls, Model 1 and Model 3 controlled for prenatal family socioeconomic position, parental absence, and parent-child relationship. The pooled estimates which were combined across 57 imputed datasets using Rubin's rule were reported here.

[a]Heterosexual boys/girls are the reference group.

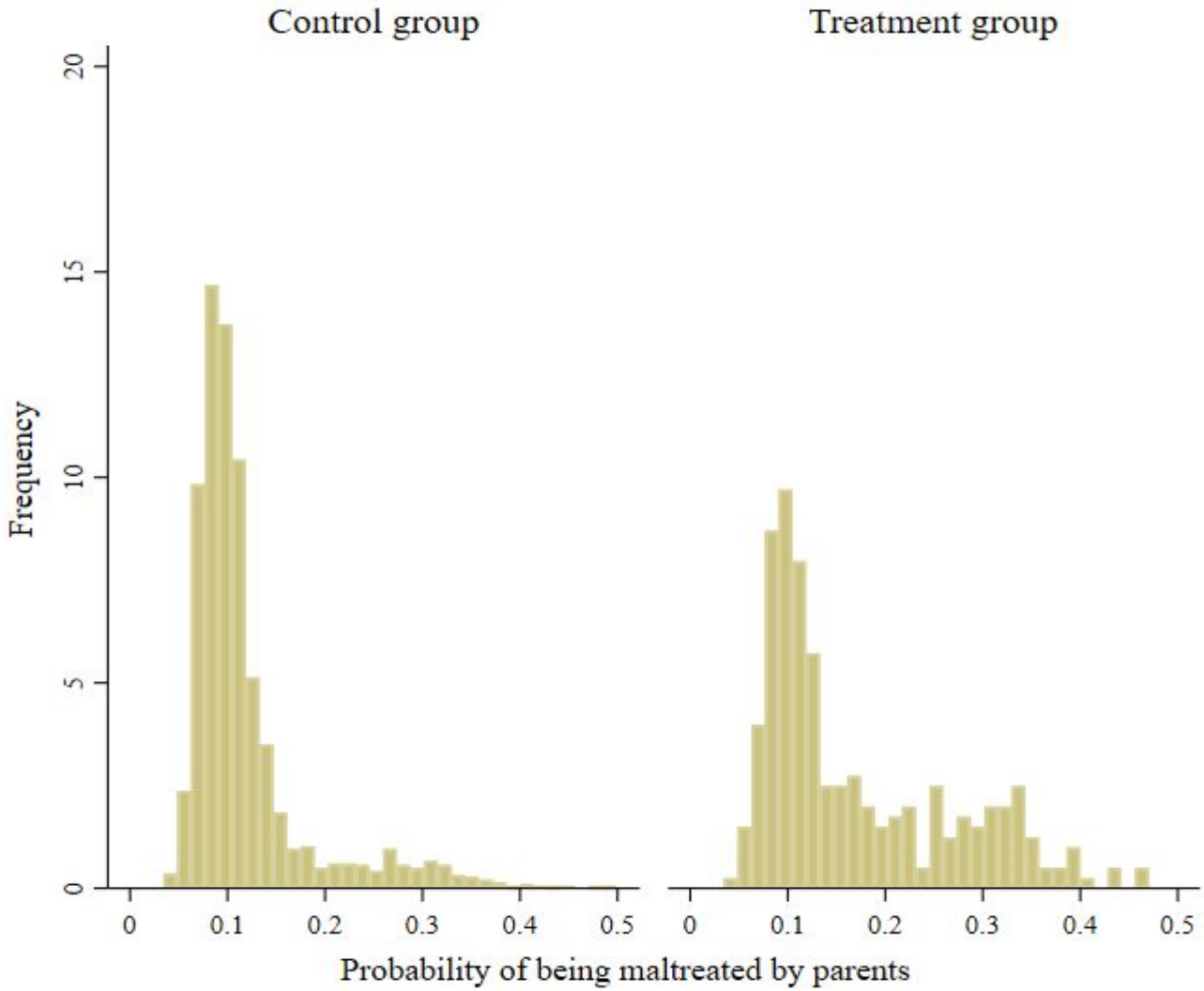
*$p < .05$; **$p < .01$.



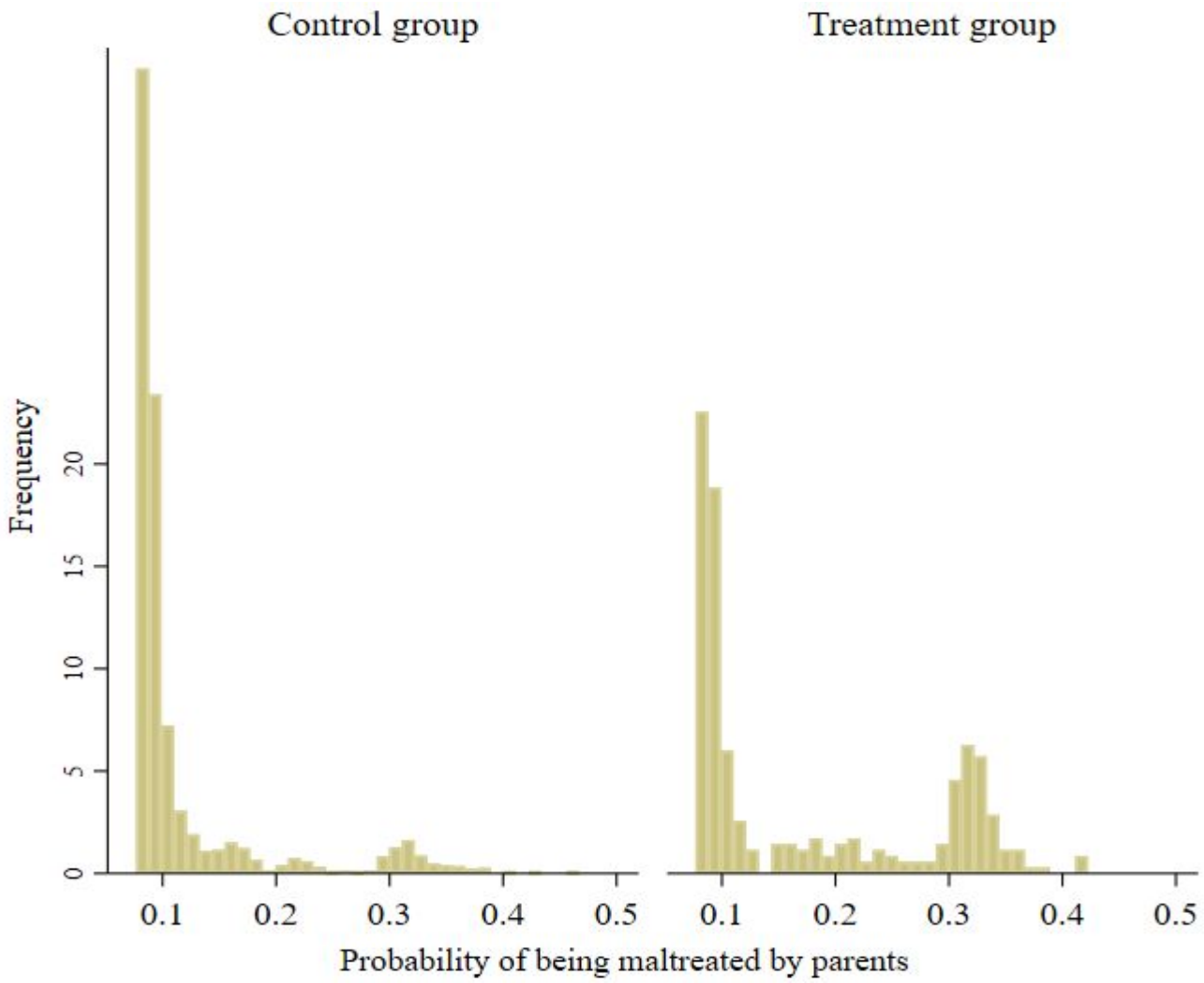
Supplemental Fig. 1. Prevalence of childhood maltreatment stratified by sex, age, and maltreatment type.



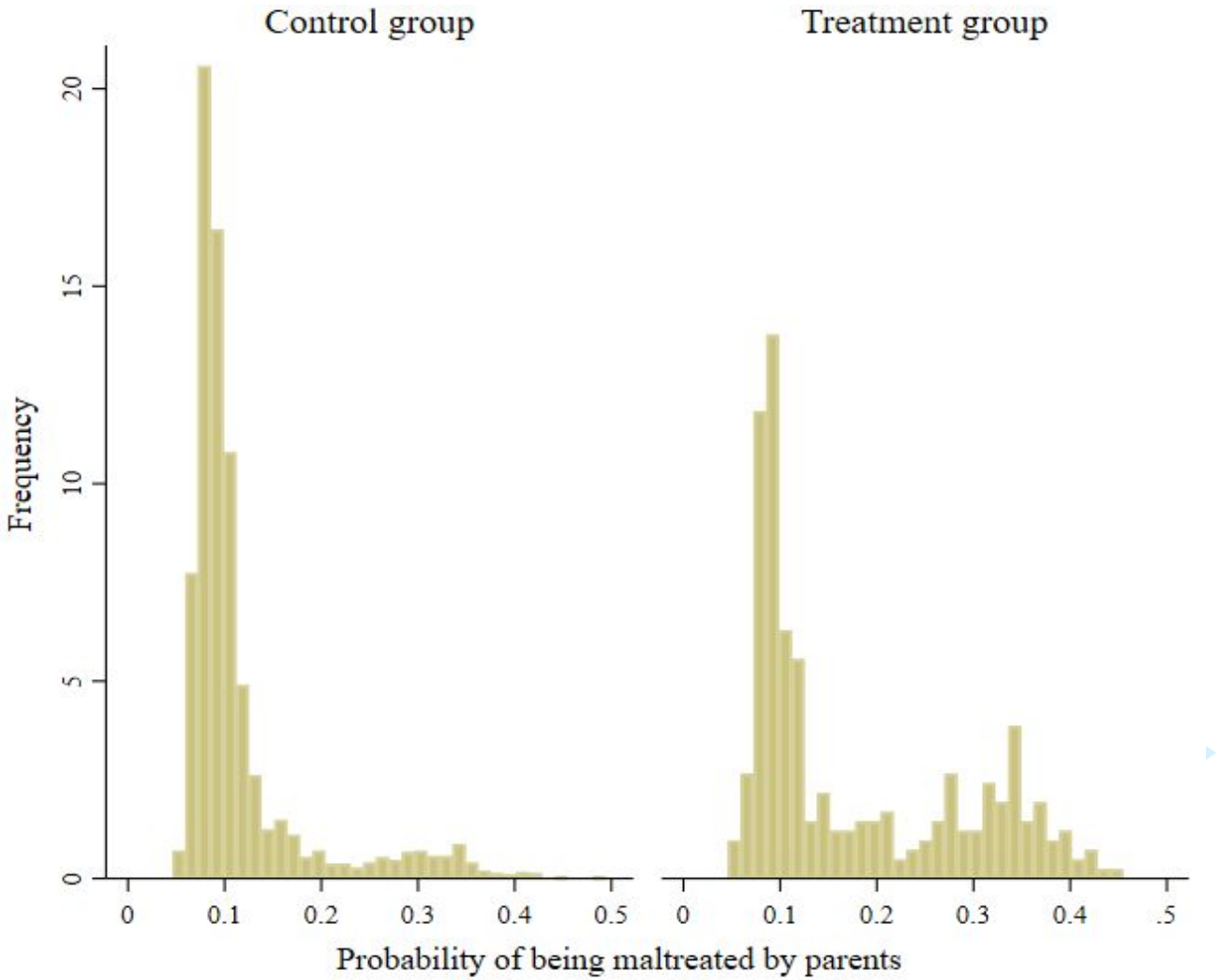
Supplemental Fig. 2. Distribution of the propensity score of being maltreated by parents for boys in Model 3. Boys with no history of childhood parental maltreatment were the control group and boys with history of childhood parental maltreatment were the treatment group. The propensity score of being maltreated by parents for each participant was averaged across 57 imputed datasets.



Supplemental Fig. 3. Distribution of the propensity score of being maltreated by parents for boys in Model 4. Boys with no history of childhood parental maltreatment were the control group and boys with history of childhood parental maltreatment were the treatment group. The propensity score of being maltreated by parents for each participant was averaged across 57 imputed datasets.



Supplemental Fig. 4. Distribution of the propensity score of being maltreated by parents for girls in Model 3. Girls with no history of childhood parental maltreatment were the control group and girls with history of childhood parental maltreatment were the treatment group. The propensity score of being maltreated by parents for each participant was averaged across 57 imputed datasets.



Supplemental Fig. 5. Distribution of the propensity score of being maltreated by parents for girls in Model 4. Girls with no history of childhood parental maltreatment were the control group and girls with history of childhood parental maltreatment were the treatment group. The propensity score of being maltreated by parents for each participant was averaged across 57 imputed datasets.